Net Zero Energy Community Systems
Workshop Overview

The workshop will characterize technology portfolios for Net Zero Energy (NZE) community systems, identify critical needs and recommend high-priority applied research opportunities. Our focus is on achieving NZE for whole community systems through optimal integration of the following seven technology areas:

a. Physical Architecture
b. Energy Conservation
c. Renewables
d. Building Envelope and Materials Sciences
e. Power & Energy Architecture
f. g.Thermal & Electrical Energy Storage
g. h.Tools & Systems Analysis Methodologies

The workshop will provide clarity for:

1) technology families needed for NZE applications;
2) technical barriers to further NZE advancements into community systems;
3) candidate applied research to solve technical barriers.

Out of these topics, a draft consensus technology roadmap will be created to guide investment in research and development. To this end, we will also seek out visions of NZE implementations along with subject matter experts' assessments of essential NZE technology thrust areas.

The NZE community system approach targets Home Station-to-Deployed Base mission needs. NZE community system promotes adaptable, modular power and thermal energy architecture. It supports a full spectrum of local mission needs from a few clustered facilities, to a sub-section of an installation, to a full installation or deployed base.

Recognizing that not all buildings will be ultra-low energy users, we must integrate a range of building types with a high range of energy consumption. The Army will have a mix of low demand facilities and high-use facilities, such as command and control facilities and maintenance facilities with high computer and environmental conditioning plug loads and industrial process loads.

NZE community system power and energy systems must offer adaptive integration of onsite power delivery, energy storage, and energy conservation.

We envision a suite of tools, systems analysis and methodologies that not only optimize design, but also day-to-day and hour-by-hour operation. Our Garrison Commanders must be able to adjust their NZE suite by continuous tailoring and optimization of energy security, affordability, environmental footprint, occupant well-being ... as appropriate depending on objectives, threat condition, resources, utility market prices and ever changing mission requirements.

Background Info

Army renewables implementation is currently focused on enticing 3rd party financing to pay for installation projects upon government commitment to pay back over 20+ years using annually funded operations and maintenance budgets.

The Army wishes to attract 3rd party financing by offering its extensive installation lands for renewable energy generation sites. Large, renewable energy sites are hoped to profitably deliver energy directly to nearby utility company grids in return for negotiated electricity rates for the Army.

There are a few individual Energy Services Companies (ESCOs) pursuing a few small renewable projects for installations. Also, Army leadership is inviting utility companies build large renewable energy generator facilities with 100+ MW of solar, wind, and/or geothermal power.

However, neither the individual ESCO projects nor the huge renewable energy generator approaches are elegant solutions that foster institutionalized NZE implementation for 100% of Army installations or deployed bases. Neither approach facilitates wide penetration of renewables blended with energy storage and ultra-low energy facilities. Both are brute force solutions that are likely to be costly over the long term and expose the Army to commercial enterprise risks of an unpredictable world financial market needed to finance cost projects. Neither approach does anything for deployed bases.

Furthermore, these approaches excludes 90% of Army installations from benefiting from on-site renewable energy generation because private companies view most installations as high risk investments.

Such site-specific solutions require costly extensive engineering for each site; costly extensive environmental review and certification; and do little for our deployed base energy security needs.

NZE for Community Systems … Candidate Vision Characteristics

We will establish an elegant suite of NZE community systems technologies and methodologies for adaptation at any Army installation or deployed base across the full spectrum of climatic zones. The NZE community systems will be tailored for climatic zone, mission needs, extent of legacy versus new facilities or any mission dependency parameter because no similar overarching energy generation-storage-delivery architecture and methodology exists today.

The current NZE solutions for individual facilities do not take full advantage of today's existing technological capabilities for community systems. We will design onsite renewable energy delivery to match today's high energy buildings and tomorrow's low energy facilities.

Using both retrofit and new construction processes, we will address existing and new facilities design, construction, renovation and operation.

We will blend together building automation, utility management and control systems as part of NZE community systems.

NZE communities will accommodate utilities privatization goals and balance contractor-run utilities and Army-owned utilities on the same installation.

By developing and establishing a uniform NZE community systems suite of possible options, the Army will reduce perceived risk by 3rd party contractors who understand profitable approaches to balanced energy generation. This should enhance Army ability to attract private money for NZE implementations.

This uniform suite can also be configured for deployed bases to further leverage Army investments in NZE community systems.

We will explore solar, wind, biomass, geothermal, and other renewable technologies specific to integration with community systems ranging from a few clustered facilities to a sub-section of an installation to a full installation.

We will address questions such as:

- What technology advancements are needed to facilitate this wide spectrum via modular, scalable, building-block suites of renewables, energy storage, and ultra-low demand-side energy efficiency?
- What advancements are needed to make such NZE implementations affordable, secure, self-healing, architecturally appealing, and operable day-to-day?
- How can a spectrum of low/medium/high Power Quality be provided that matches up to the spectrum of Power Quality required by the today's and tomorrow's Army missions?
- How is intermittency of candidate renewables best accommodated through innovative storage via central district storage function, as energy storage embedded in building envelopes, or combinations of the two?

Integration of power, storage, and facility demand will require sophisticated control architecture. Controls need to be fast and smart. Power stability may be an issue for these very low power sources during sudden transition from utility power to onsite distributed power, sometimes referred to as 'islanding.' How might this be dealt with?

For major events such as loss of utility power or loss of an onsite distributed power unit, the control response must be in milliseconds. This level of response can be achieved by each electrical component of the NZE community systems using autonomous controls, based only on local information. The longer time frame needs of the NZE electrical and thermal components are likely provided by a distributed system controller, which optimizes the operation of each component of the NZE, depending on mission.

How can the overall NZE community system be implemented as a pre-planned product improvement concept? We need to provide investment decision-making insights that provide logical staged upgrade roadmaps for Army facilities, utilities, etc. We cannot afford to do everything in a few short years. The end objective is NZE for the whole community; not for each individual facility. So, we need to determine how much energy conservation we can bring to older facilities in an affordable way and how. There is a cost trade-off between energy savings achieved by new technology installation and first costs. Do we focus on envelope airtightness and insulation, heating and cooling systems, etc? Do we defer heating and cooling to centralized architecture? Do we expect a major advancement in some technology in 5 years and thus we defer replacing that technology componet until ready? Pre-planned product improvement encompasses all of these and more considerations. The key to lay out the implementation for the entire fleet of installations up front … with the end in mind. We must not embrace a process of knee-jerk spot solutions that offer quick headline sound bites but do little for long-term institutional NZE achievement at the community level.

The system will be phased in over many years to accommodate both funding limitations and technology gaps. So it needs to have clearly delineated and pre-planned engineering interfaces built in to accept new technologies when ready and affordable – without costly and time-consuming retrofits. For example, building envelope thermal storage appears to be a meaningful objective, but costly for retrofit.

We will also address questions such as:

- How should we craft our NZE technology roadmap in a way that thermal storage can be incorporated later without major perturbations?
- Similarly, what structural considerations should be addressed now in order to accommodate new solar roofing materials at a later time?
- What architectural considerations pave the way for later incorporation of energy storage, renewables, energy conservation, building automation systems?

The NZE community systems vision will include embedded sensing elements, self-diagnostics of conditions that enables self-healing. They will perform continuous self assessments to detect, analyze, take precautionary measures to avoid, respond to, and as needed, restore components or network sections. They will resist attack either via Global War on Terrorism or malicious pranksters.

Security requires a system-wide solution that will reduce physical and cyber vulnerabilities and has redundancy to eliminate, or recover rapidly from, disruptions. Both its design and its operation will discourage attacks, minimize their consequences and speed service restoration.

The NZE community systems will intelligently blend weather forecasts and proactively optimize energy storage, super dehumidify, or otherwise modify energy generation to ready the overall system before predicted day-to-day conditions occur.

The NZE community systems will provide an umbrella architecture suitable to the Army's different installation types: heavy industrial, light industrial, training, power

projection. They will facilitate a common core of technology for all and specialized configurations tailored for each unique mission.

Intelligently postured for installation mission adjustments in coming days / weeks such as training installation cyclical groups of troops coming in for a month then a week down-time of dormancy for a portion of the installation followed by another group of troops perhaps using only a fraction of available facilities.

The combinations of used and unused, 24/7 … 12/6 hour coverage, etc. are extensive. A NZE community system autonomously takes care of all eventualities based on whatever metrics the Garrison Commander establishes as most important. It provides the high level of power quality essential to command, control, communications, and intelligence missions by Army installations and deployed bases.

New power quality standards will balance load sensitivity with delivered power quality at a reasonable price. The NZE system will optimally supply varying grades of power quality at different cost levels established by the Garrison Commander.

We will accommodate all generation and storage options that seamlessly integrate many types of electrical generation and storage systems with a simplified interconnection process analogous to “plug-and-play”. Asset management and operation of the grid will be fine-tuned to deliver the desired functionality at a minimum cost.

This does not imply that assets will be driven to their limits continuously but rather that they will be managed to efficiently deliver what is needed when it is needed.

Workshop Mission Summary

These NZE community systems characteristics describe a vision that is more affordable, more resilient and distributed, more intelligent, more controllable and better protected than today’s installation infrastructure. Through the many avenues outlines, the Net Zero Energy Workshop will help provide a clear, timely and cost-effective path to Army mission success on many levels.